

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 25, 1999

GROUP CHAIRMAN'S FACTUAL ADDENDUM CONCERNING RE-EXAMINATION OF FUEL PROBES

DCA-96-MA-070

A. ACCIDENT

Location : East Moriches, New York
Date : July 17, 1996
Time : 2031 Eastern Daylight Time
Airplane : Boeing 747-131, N93119
Operated as Trans World Airlines (TWA) Flight 800

B. SYSTEMS GROUP

Chairman : Robert L. Swaim
National Transportation Safety Board
Washington, D.C.

Member : Richard Lidicker
Boeing Commercial Airplane Co.
Seattle, Washington

Member : Jon Regimbal
Federal Aviation Administration
Seattle, Washington

Member : Chris Hartonas
Federal Aviation Administration
Seattle, Washington

Member : Lou Taylor
Honeywell Commercial Aviation Systems,
Sensor Products Operation (CAS-SPO)
Minneapolis, Minnesota

Member : William Savage
Honeywell Commercial Aviation Systems,
Sensor & Guidance Products
Minneapolis, Minnesota

Member : Ken Craycraft
Trans World Airlines (TWA)
Kansas City, Missouri

C. SUMMARY

On July 17, 1996, at 2031 EDT, a Boeing 747-131, N93119, crashed into the Atlantic Ocean, about 8 miles south of East Moriches, New York, after taking off from John F. Kennedy International Airport (JFK). The airplane was being operated on an instrument flight rules (IFR) flight plan under the provisions of Title 14, Code of Federal Regulations (CFR), Part 121, on a regularly scheduled flight to Charles De Gaulle International Airport (CDG), Paris, France, as Trans World Airlines (TWA) Flight 800. The airplane was destroyed by explosion, fire, and impact forces with the ocean. All 230 people aboard were killed.

A group of party representatives was convened at the Safety Board Materials Laboratory in Washington, DC, from April 27 through May 1, 1998, to examine fuel probe components from the TWA flight 800 wreckage. The activity included a re-examination of components that had already been examined and fragments of fuel probes and compensators that had not previously been documented by the group. The group of new fragments included parts recovered from the ocean after the last group meeting and parts that had been found mixed with other hangar wreckage.

Two general types of fuel probe and compensator terminal block wire retention designs were found. Both styles are illustrated and described in the Honeywell Overhaul Manual.¹ The wire retention area of the earlier style of terminal blocks, used in Series 1-3 assemblies, has wires between a knurled area of conical plastic points by a metal bracket. The Overhaul Manual showed that "smooth" terminal blocks used in Series 4 and subsequent did not have the knurled feature. The illustration shows that wires attached to Series 4 and subsequent assemblies are routed through the opening of a nylon (plastic) "P" shaped clamp.

One compensator had plastic internal parts with lower edges that appeared resolidified, blackened, and pitted. Visual inspection did not detect similar damage to Teflon (PTFE) parts and two types of wire insulation found inside the fragment. Similar damage was also not found to the external features of the compensator fragment. The compensator was identified as fragment #80 and had not been described by an earlier set of group notes. According to the FBI Log number, the part had been recovered on about April 22, 1997, by a trawler that had been in what had been called the "green" area. The compensator did not have a terminal block, but had marks that were unique to the FG6C2 design that would have been built with an unknurled "smooth" terminal block.

¹ The overhaul manual and other information were used in the Safety Board Public Hearing into TWA flight 800 of December 8-12, 1997, and are contained in Systems Group Chairman's Factual Report of Investigation, dated November 17, 1997. The Fuel Quantity Tank Unit Overhaul Manual pages cited are located in section 9C, pages 208-209 (9C208-209).

D. DETAILS OF THE INVESTIGATION

The details of these activities are additions to the previous descriptions of the FQIS components, contained in the November 17, 1997, Systems Group Chairman's Factual Report of Investigation, section 9A, pages 87-100. The fragment numbers used in the Factual Report have been retained and new fragments have been added.

Sources of information for installations, descriptions of fuel probe Series numbers, and fragment features include the following:

1. References to fuel tank unit (probe) nomenclature and features have been taken from Honeywell Overhaul Manual for Part FG420 Tank Units, primarily Figure 1101 (Systems Group Chairman's Factual Report of Investigation, dated November 17, 1997, pages 9C204-209).
2. References to compensators were taken from the Honeywell Overhaul Manual for the Part FG6C (includes 9C247).
3. Fuel probe installation locations (for example, the first fragment below calls out "F62") were taken from TWA Wiring Diagram Manual 28-41-01, page 102 (9C188-189, 9C246) and Boeing drawing 60B92010 (9C187).
4. Wiring information has been found in Honeywell drawing C13467AA01 and various TWA Wiring Diagram Manual pages contained in Chapter 28 (9C264-268), as well as from Chapter 91-00 of the TWA Master Wire Bundle drawings.

Item (Fragment)	Length (in.)	FBI ID	Mfg Identification	Tank
1			FG420-A41	#4
The terminal block is a Series 3 type, with set screws to attach the FQIS wires. The probe is marked with MFD and FT dates of OCT 1969. ² The number of wires and HI Z wire termination of this part number are unique to the tank 4 probe (Boeing identification) F62.				

According to Honeywell personnel present during the activity, the set-screw type of connections were not developed by Boeing or Honeywell. The modification replaced the screws used to attach wires to the Series 1-3 terminal blocks. The replacement set-screws allowed use of nuts to attach wires, as in Series 4 and subsequent fuel probes.

² MFD denotes the manufacturing date. FT denotes the Functional Test date.

2

FG420-A8

#1R

A data plate states that this is a FG420-A8, Series 3, S/N A-132. A wire number marking (W722-Q107) was found that wire diagrams show unique to tank 1R. The terminal block is the knurled type, with a metal clamp, as used in Series 3 and earlier probes. The dates marked on the outer shell are MFD OCT 69 and FT OCT 69. The wire attachment connections have set-screw types of hardware. The LO Z terminal has the set screw installed with the allen-wrench point reversed and hidden.

3

FG420-A36

#4

The HI-Z terminal is a threaded stud, as shown used in Series 4 and later terminal blocks. The head of the stud was crushed into the probe.

This fragment combines with fragments 35 and 50 to create a complete FG420-A36 probe, unique to tank 1 or tank 4. The group noted that the another FG420-A36 was identified and that the remaining probe identification is F64, from tank 4.

4

FG420-A39

#1 or #4

The end of the fragment matches the fracture of fragment 6. Information concerning the opposing probe is described in fragments 64 & 77.

5

FG420-A34

#4

The HI Z mounting bolt for the terminal block has a flat washer, not a lock washer, and the flat washer was unique to Series 5 terminal block installations (and subsequent). The probe is marked with MFD and FT dates of JUN 1970.

The fragments add to the nearly complete probe length, with the inner electrode. Note: Item 51 does not match these parts.

A wire fragment in an attached bag has 3 partial tags with number markings of F65, W1180-Q152. The Boeing wiring diagram shows the markings for this probe and wire are at installation location F65 in tank 4.

6

FG420-A39

#1 or #4

The probe is marked with MFD and FT dates of NOV 1970. The end of the fragment may match the fracture of fragment 4. Note: Data concerning similar fragments from the opposing probe, found to be fragments 64 & 77, is contained in descriptions of fragments 64 & 77.

7

FG420-A38

#1

The HI Z terminal has a tuning washer, as used in the Series 5 and subsequent terminal blocks. The probe is marked with MFD date of MAY 1970.

Two FG420-A38 probes are installed in the B-747. Item 14 had probe features and a wire identification that used in the tank 4 installation. The installation number in tank 1 is F11. The inner electrode is complete at 21 inches; the outer electrode is 15 inches long.

#2 or #3

The ends of fragments #17 and #8 match and the cumulative length is the approximate length of one complete inner probe element. These fragments add to 38 of 58.27 inches of the outer shell, with the bottom end missing. These fragments are separate and different from #38 and #71, which assemble into a second -A28 probe. Neither FG420-A28 probe has features that identify it to the left or right wing.

#1 or #4

The marked MFD and FT are JUL 1970. A fragment of the upper terminal block top has the thinner casting of the unknurled type, found on an exemplar part that Honeywell provided. This smooth type of casting was used in Series 4 and subsequent probes. The HI Z mounting screw is consistent with the Series 5 or subsequent terminal block. This fragment has the length of a nearly complete probe.

#4

The probe is marked with MFD and FT dates of FEB 1970.

Two of the FG420-A35 probes are used in the B-747 and fragment #61 was another -A35, with a wire identification used in the tank 1 installation. The remaining installation shown on the installation drawing is probe F71 at tank 4.

#2

The fracture surfaces and overall length of this fragment, with #32, add to one FG420-A26 probe. The other FG420-A26 that was found has wiring from the #3 main tank. The remaining location that the installation and wiring diagrams show would use a -A26 is the #2 main tank.

#2

The outer tube was found with MFD and FT dates of AUG 1970. Two of the FG420-A24 probes are used in the B-747 and fragment #18 has a wire identification used in the #3 tank. This probe (fragment 12) has material that would overlap with #18. The remaining installation shown on the installation drawing is in tank 2.

#4

The length of the total probe was verified from the (above) activities of August 25 and October 16, 1996. This length was found approximately equal to fragments #1 and #13 and alignment was verified at the ends of the outer tube fragments. Item #1 was found with a wire used at the F62 installation in the #4 main tank.

#4

The stud type of terminal was found, as used in Series 4 and later probes, but without a “tuning washer” (Fig. 1101, Item 26A) that was used in Series 5 and later assemblies. The stud used for the HI Z terminal was found to be 1.562 inches in length, a measurement unique to the Series 4. The probe and wire numbers are shown in the Boeing installation identification as unique to installation F63, as used in tank 4. Of the orange lettering used for the MFD and FT dates, only “70” is visible. The fragment is different than fragment 7.

15

FG420-A33

#4

The data plate identified this as a FG420-A33, Series 5, S/N Y20. The MFD and FT dates marked on the outer shell were MAR 71.

Item 42 is a FG420-A33 with attached wires that are used in tank 1. Tank 4 is the remaining installation location for the FG420-A33 probes.

16

FG420-A18

#2 or #3

The probe is marked with MFD and FT dates of NOV 1971. The HI Z mounting has a flat washer, as used in Series 5 and subsequent assemblies.

17

FG420-A28

#3

Wire numbers were found that were used in the Boeing F58 installation in tank #3. The HI-Z is a stud, as used in Series 4 and later terminal blocks, as well as the “tuning washer” that was used in Series 5 or later fuel probes (Fig 1101, Item 26A). The terminal block is the “smooth” type. Marked on the outer shell was FEB 1971 for both MFD and FT dates.

The ends of fragments #17 and #8 match, also combining to a nearly complete inner element. These fragments add to about 38 of 58.27 inches of the outer shell, missing the bottom end. These are separate and different from #38 and #71, which assemble into a separate -A28 probe.

18

FG420-A24

#3

An attached wire fragment has a number that is used in the #3 main tank at Boeing installation F55. A data plate identifies this as a FG420-A24, Series 6, S/N Z150.

Unique inner element steps that are used only once per probe are in both this fragment and probe fragment #12.

19

FG420-A20

#2 or #3

The HI Z mounting stud terminal is on the inner element, with a flat washer and a “tuning washer” that are unique to the Series 5 and subsequent fuel probes. The probe is marked with MFD and FT dates of JUN 1970.

20

FG420-A21

#2 or #3

The HI Z mounting bolt for the terminal block has a flat washer and a “tuning washer,” not a lock washer. These are features shown in the Overhaul Manual as unique to Series 5 and subsequent probes. The probe is marked with MFD and FT dates of JUN 1970.

21

FG420-A27

#2 or #3

The terminal block has a nylon Adel clamp for strain relief, rather than the metal clip used on Series 1-3 fuel probes (per Fig 1101). MFD is DEC 1970 and FT JAN 1971.

22 Comp.

FG6C2

The part marked with S/N Z-1213 and Honeywell manufacturing records showed that the “Z” denoted a 1970 manufacturing date. The FT date marking was NOV (year illegible). The name

plate shows FG6C2, Series 1, which Honeywell records show to be a terminal block style that has no knurling. No identifying features or attached wires were found that described the original location. The compensator has no evidence of general sooting to the internal or external features.

The inner diameter of an inner shell (inner LO Z) has a small black mark that would be opposite an upper cut-out, according to position on a Honeywell engineering drawing (FG6C). This is the location of a blue plastic spacer, according to the drawing. Other marks are on the walls opposite to the other two cut-outs, as well, but without the black.

Terminal studs (2) found in the plastic bag were from a terminal block style that would not have been knurled. The LO-Z terminal stud has black deposits around the interior plastic sleeve of the attached crimped terminal that is on the terminal side. The black is also at the wire end of the LO-Z crimped metal and the plastic sleeve. Orienting the stud and crimped connector on a substitute terminal block found that the crimped connector was oriented up and to the right, so that the crimped wire connector covered the "Z" of the "LO Z" marking.

The HI-Z crimped connector has significantly less blackening and the blackening that exists is primarily on the exposed portion of the wire.

An internal blue (LO-Z) wire from within the compensator had corrosion in the crimped connectors. One had a slight amount of darkening in the plastic, but not the blackened features seen in the LO-Z crimped connector.

23 Comp.	FG6C	Rt. Surge
This compensator had been installed in the right surge (vent) tank when the wing tip was recovered.		

24 Comp.	FG6C
(No factual information added.)	

25	FG-420-A8	#4R
Documentation is contained in NTSB Laboratory Report No. 96-160.		

26	FG420-A37	#1 or #4
The probe is marked with MFD and FT dates of JAN 1971. The HI Z stud is missing the bolt head. This is a nearly complete length of a FG420-A37 probe.		

27	FG420-A13	CWT
The HI Z mounting bolt for the terminal block has a flat washer, not a lock washer, and the flat washer was a feature unique to Series 5 and subsequent assemblies, according to the Overhaul Manual. The probe is marked with MFD and FT dates of APR 1971. Wire numbers correspond to Boeing number F41.		

28	9-23-96-5 RK	FG420-A22	#2 or #3
(No factual information added.)			

29 9-19-96-1 DJ/LA FG420-A17 #2 or #3

The terminal block is not the knurled type that was used in Series 3 or earlier.

30 9-22-96-1 DEL FG420-A27 #2 or #3

The HI-Z bolt from the terminal block has the “tuning washer” that was used in Series 5 or later fuel probes (Fig 1101, Item 26A).

31 9-23-96-5 RWK FG420-A30 #1 or #4

The terminal block is not knurled and has a nylon strain relief clamp attached, as used in Series 4 and subsequent probes. The assembly was not taken apart to examine for a “tuning washer.”

The fragment appears to have both manufactured ends.

32 9-20-96-35 JNY/PW FG420-A26 #2

The top half of the terminal block is not the knurled type. The HI Z stud has the “tuning washer” of the Series 5 and higher terminal block assembly.

The fracture surface and length visually match with fragment #11. Fragment #11 was identified as from tank #2.

33 9-21-96-1 FG420-A20 #2 or #3

The outer shell was cut to gain access to the HI Z terminal. The HI-Z has the “tuning washer” that was used in Series 5 or later fuel probes (Fig 1101, Item 26A).

34 9-23-96-5 DMW FG420-A23 #2 or #3

The terminal block is not knurled and has a nylon strain relief clamp, as used in Series 4 and subsequent probes. The HI Z has a “tuning washer,” used in Series 5 assemblies or subsequent.

The fracture surface and length of this fragment match with the top of fragment #63.

35 9-20-96-33 JMV/BW FG420-A36 #1

The fuel probe has a terminal block that does not have a knurled area, as used in Series 4 and later terminal blocks. The terminal block was not disassembled to examine for a “tuning washer,” as used in Series 5 or later fuel probes (Fig 1101, Item 26A). Wire identification marks were found that were used in tank #1 at Boeing location F12.

The fracture surface of the fragment mates with fragment 50, identified as a tank #1 part.

36 9-23-96-5 ON/NY Compensator #1
Wires were found looped to pass through the nylon strain relief (Adel) clamp twice (photo in the November 17, 1997, Systems Group Chairman's Factual Report on page 9E1). The terminal block is the "smooth" style that is unique to the Series 4 and subsequent terminal blocks. The probe is marked with MFD and FT dates of JAN 1971. The rolled bottom is unique to the FG6C1 and FG6C2 series of compensators, although all FG6C1 parts had the knurled terminal block.

A F7/F59 installation wire marker that is used in tank 1 was found attached.

37 9-23-96-5 FG420-A29 #1 or #4
The HI-Z bolt from the terminal block has the "tuning washer" that was used in Series 5 or later fuel probes (Fig 1101, Item 26A)

38 9-21-96-1 FG420-A28 #2 or #3
Matches with fragment #71 & #38 to form a nearly complete probe, missing several inches from the middle and top, with #38 as the lower portion.

39 9-20-96-33 DJ/LA FG420-A19 #2 or #3
The fragment has a HI Z mounting bolt that has the tuning washer" (Fig 1101, item 26A) of a Series 5 or later terminal block. The fragment has a HI Z stud assembly (fragment 5A), which is Series 4 or above. A small fragment of wire is attached by the metal part of a crimped connector to the HI Z stud. A small amount of blackening is on the crimped connector and the wire visible at the stud end of the connector. The wire fragment protruding from the end that is opposite the stud has no insulation remaining and has no blackening.

40 9-20-96-33 DJ/LA FG420-A22 #2 or #3
The probe is marked with MFD and FT dates of FEB (unknown year).

41 9-20-96-35 DJ/LA FG420-A32 #1 or #4
(No factual information added.)

42 9-20-96-33 JMY/DW FG420-A33 #1
The HI Z washer was of the flat washer, not lock washer, and the terminal block had a nylon Adel clamp, each of which are features unique to Series 5 and subsequent. Wiring identification is used in Boeing tank 1 at the probe F18 installation. The probe is marked with a FT date of MAR 1971.

43 9-22-96-1 DEL FG420-A25 #2 or #3
The HI-Z connection feature is a stud, as used in Series 4 and later terminal blocks, and has the "tuning washer" that was used in Series 5 or later fuel probes (Fig 1101, Item 26A).

44 10-13-96-3 TLL/EP FG420-A11 #4R
The MFD and FT dates marked are APR. A scrape through the lettering covers the year markings, obscuring the MFD year. The FT can be seen under magnification to be 1971. The HI

Z mounting bolt has a flat washer and a tuning washer, as used in Series 5 and subsequent fuel probe assemblies.

The group noted that tank 4R had resolidified aluminum, blackening, and soot (probe installation F77). Tank 1R had none of these features. See also the notes for fragment 58 (tank 1R, installation F4) and mating fragment 65.

45 Comp. [None] Compensator

The bag contains miscellaneous parts. The bottom of the outer compensator shell has the rolled feature of the FG6C1 or C2. The terminal block parts each has a curved feature that is found unique to a single terminal block. Each terminal block fragment has features of Series 4 or later terminal block; one having a nylon Adel clamp attached and the other not having the open "pass-through" feature of the earlier terminal block series. In the bag is a red LO Z wire, marked "F11-63," which is a probe feature and not from a compensator. Black wires ("pig-tail" ground connections) are also not a compensator feature, but are used for wire terminations at fuel probes. A photo was enclosed in the parts bag and shows the black wires attached to the terminal block fragment that does not have the nylon Adel clamp. The wires were reattached to resemble the photo and no unique orientation features were noted.

46 9-24-96-16 JM FG420-A18 #2 or #3
(No factual information added.)

47 9-21-96-1 FG420-A37 #1 or #4
The HI Z is a stud type of terminal with a flat washer and "tuning washer," as unique to the Series 5 and subsequent fuel probes.

48 9-24-96-16 PMO FG420-A ?
(No factual information added.)

49 9-22-96-1 DEL FG420-A12 CWT
(No factual information added.)

50 9-20-96-33 DJ/LA FG420-A36 #1
The fracture surface mates with the end of fragment 35, which had wires used in tank #1.

51 9-20-96-33 JMY/DW FG420-A34 #1
The small amount of fragments are duplicative of what was found on fragment #5. The remaining installation number is F13 in tank 1.

52 9-22-96-1 FG420-A25 #2 or #3
The fracture matches with fragment #43, not fragment #42, based on fracture surface and length, verifying this to be the FG420-A25 part, used in tanks #2 and #3.

53 9-22-96-1 FG420-A15 CWT
The HI-Z terminal is a stud, as used in Series 4 and later terminal blocks. The "tuning washer" found was used in Series 5 or later fuel probes (Fig 1101, Item 26A).

54 9-22-96-1 FG420-A20 #3
The terminal block is not knurled and has a nylon strain relief clamp. The style was used in Series 4 and subsequent probes. The HI Z is not with the parts. A separate LO Z wire found in the parts bag is twisted downward on the stud.

55 [None]
(No factual information added.)

56 11/23/96-58 JB FG420-A23 #3
The terminal block is not knurled and has a shadow that matches the edges of a nylon strain relief clamp. The features found were used in Series 4 and subsequent probes. The HI Z mounting stud is missing the end that could have a "tuning washer."

The fragment was renumbered as -A26 after positive identification of two -A23 probes. The wire fragment described by the April 14, 1997, group activity has been found to have been routed between the -A23 and -A26.

57 11/17/96-11 DRR FG420-A23 # 2 or #3
The terminal block is not knurled and has a nylon strain relief clamp. The features found were used in Series 4 and subsequent probes.

Fragments 57, 69, and 76 had distance measurements between varying diameters that are unique to the top, middle, and bottom (respectively) of one -A23 probe. The mating fracture surfaces and lengths combine to one nearly complete probe, separate from the lengths of the opposing -A23 fragments.

58 11/17/96-9 GC FG420-A11 #1R
The small fragment has a terminal block of the knurled type and has the larger relief (pass-through) beneath the center area that was used in Series 1-3 terminal blocks. A small section of plastic wall was found broken next to the HI Z mounting location. The HI Z mounting screw is consistent with a Series 3 terminal block. The external plastic sleeve on the crimped HI Z wire connector is blackened, curled, and possibly heat damaged.

Found with fragment 65 to match the opposing (clearly burned fragment #44, installation #F77) FG420-A11 from tank #4R in the area of the terminal block. The installation drawings show only two usage locations and the remaining number found is tank #1R at installation #F4.

59 2-13-97-134 W[illeg.] FG420-A12 CWT
The terminal block is not knurled and the nylon strain relief clamp used in Series 4 and subsequent probes.

60 11-11-96-19 SC FG420-A10 # 4R
The terminal block is the unknurled type used in Series 4 and subsequent.

61 11-14-96-105 LMV FG420-A35 # 1

The terminal block is a non-knurled type and has a tuning spacer on the HI Z stud, features used in the Series 5 and later parts. The MFD and FT were found to have been incorrect in the original factual description (April 14, 1997) and the dates should read JUN 1970, not JAN 1970.

62	10/27/96-1 DEL	FG420-A18	#2 or #3
(No factual information added.)			

63	12-14-96-46 K	FG420-A23	#2 or #3
The fracture surface and length mate with the bottom of fragment #34.			

64	11 - 17-96-2 GC	FG420-A39	#1 or #4
The fracture of this fragment matches the fracture of fragment #77, from tanks 1 or 4. Note: Another FG420-A39 probe was assembled from fragments 4 & 6.			

65	12-14-96-65	FG420-A11 or -A29	#1R, #4R, #1, or #4
Found with fragment 58 to be the same as the -A11 bottom section (burned fragment 44, installation F77). The remaining number is from tank 1R, probe F4.			

66	11 - 16-96- 10 GI(?)	FG420-A17	#2 or #3
(No factual information added.)			

67	10-8-96-1,LEB-EP		
(No factual information added.)			

68	11-11-96-69 GJ	FG420-A14	CWT
(No factual information added.)			

69	11/17/96-11 DRR	FG420-A23	#2 or #3
(No factual information added.)			

70	11-5-96-25 SKC	COMPENSATOR	# 4R
This part has the FG6C2 type of flat collar, rolled bottom edge to the outer shell, and the unknurled terminal block. The data plate is missing. The MFD and FT dates marked on the outer shell were MAR 71.			

71	11-16-96-137 GC	FG420-A28	# 2 or # 3
This is a 15.5 inch combination of two pieces, the longer being 11 inches long. The fracture of this fragment matches with the fracture of fragment #38.			

72	11/16/96-168 SHE	FG420-A16	CWT
(No factual information added.)			

73 10/30/96-2 DMW FG420-A25 #2 or #3
The HI Z screw from the terminal block was found in the assembly. The screw has a “tuning washer” (reference item 26A, fig 1101) and flat washer that the Honeywell Overhaul Manual shows only to be in the Series 5 (and subsequent) terminal blocks.

74 2/3/97-220 GF FG420-A12 CWT
(No factual information added.)

75 11/23/96-198[illeg.] COMPENSATOR
An orange date “NOV 70” is where the MFD typically is located on other fragments, but other markings are illegible. The terminal block is the unknurled type.

76 11-17-96-15 GC FG420-A23 #2 or #3
(No factual information added.)

77 11-23-96-208 DP FG420-A39 #1 or #4
Fragments 77 and 64 have a raggedly torn edge that matches, to a combined length of the total probe. These fragments do not mate with fragments #4 or #6. Fragments #4 and #6 were found to have fractures that mated with each other. No further identification found regarding installations of this fragment in tank 1 or 4.

78 9-9-96-49 BJW FG420A-13 CWT
(No factual information added.)

79 3-1-97 71DM FG420A-9 4R
This is a nearly complete probe that includes burned and molten/resolidified plastic end caps, but no terminal block. The group noted that although the part would have been interchangeable between the #1R and #4R tanks, but that only tank #4R had burned features. The HI Z mounting screw does not have a “tuning washer.” The Series 4 part used a longer HI Z mounting screw, identifying this by elimination as a Series 1-3 part. The MFD marking was OCT 1969.

80 4-30-97-62 G FG6C2
The fragment is the support tube (central core) of a compensator. The walls of the top third of the support tube were found flattened together, with the terminal block bands remaining intact. The longitudinal edges of the flattened portion were not connected. The fragment was found without the plastic mounts, the terminal block and the lower elements. No MFD or FT numbers are visible along the length of the tube.

Although the terminal block is missing, the white Teflon insulator from beneath the terminal block remains attached to the support tube. A demarcation in the reflection of light from the anodized surface of the fragment aligned with the (outer electrode) top cover of a FG6C1 or C2 exemplar. The HI Z attachment machine screw sleeve (FG6C Overhaul Manual, Fig. 1101, item 38) from the lower end of the compensator has a diameter of .124 inches, corresponding to parts used in FG6C2 or FG6C4 Series 1, both of which use non-knurled “smooth” terminal blocks.

The location of the white Teflon insulator on the tube was marked with a red marker during the activity and the Teflon part was released by slipping off the band clamp. The upper third of the tube was then spread apart. The edges of the spread surfaces were the existing fractures in the tube. Two screws were found trapped in the collapsed portion of the tube. One internal screw was found with material missing from one side of the screw head. A protrusion of different shade and texture was seen under (75X) magnification in the missing area of the screw. The lower two thirds of the tube was split with small snips that did not create metal chips or dust. The cuts were minimized by cutting only to connect the existing splits and damage.

Once the flattened top of the support tube was opened, four plastic electrical parts inside were found blackened, pitted, and resolidified along the lower edges. The blackening had an upward flow pattern and was confined to the lowest edges of a plastic sleeve that covers a wire shielding connection, two plastic insulators on ring connectors, and the plastic leadwire support. The general features of each plastic part did not appear to have been molten and each part retained its color. The bottom of one of the tube halves had a soot accumulation, but this was in an enclosed area that did not have the scouring marks found on the external surfaces or smoothness of the inner surfaces.

Plastic parts were found inside the tube that had not blackened, including two types of wire insulation and the internal features of the Teflon components. The FG6C Overhaul Manual (docket page 9C247) calls out use of MIL-W-16878/5 (PTFE) leadwire, which is the type of fuel-exposed wire that was found through-out the B-747 fuel tanks during the investigation. The blue and black wire insulations resembled this type of material. The other type of insulation found in the compensator was a clear plastic cover, over an off-white woven inner material that covered the core conductor.

The only potential external evidence of blackening damage on the external surface was a small darkened flow pattern around a hole that was under the terminal block Teflon insulator. No other external evidence of soot or heat was found, including in the enclosed areas of folded aluminum where it had been bent, or under the Teflon insulator.

The FBI Log number was compared with recovery records. The records showed that for that FBI Log number, the part would have been found in area PP, lines 93 TWA W and 94 TWA E. Trawling recovery charts showed that this area corresponded to what had been called the “green” recovery zone and that the parts had been accepted from the trawler on 4/22/97.

81. Miscellaneous loose parts found in the bottom of the shipping boxes include:

An assembly strap for a terminal block (Fig 1101, item 3 or 4).

A loose terminal block stud with an attached crimped wire connector. The crimped connector is oriented on the block in a direction that holds the wire downward, appropriate for a HI Z terminal. Held over an exemplar terminal block, the position interferes at the SHLD and LO Z positions. The diameter of the stud matches a HI Z part.

An end cap from a probe.

82

3-26-97-34 GL

FG420A-34

#1 or #4

This is a 6 inch fragment of the inner and outer elements, marking numbers were not found on either fragment. The diameters and length only match the configuration of the bottom of the FG420-A34, as used in #1 or #4 main fuel tank, in the F13, or F65 installations. The group noted that fragment 51 has a similar area and was found to be the upper portion of an F13 installation.

83

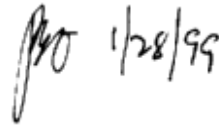
FG420A-

This is a 6 inch probe fragment, including both inner and outer elements. It is the midsection of a probe that has no unique exterior features, such as mounting holes or for the terminal block.

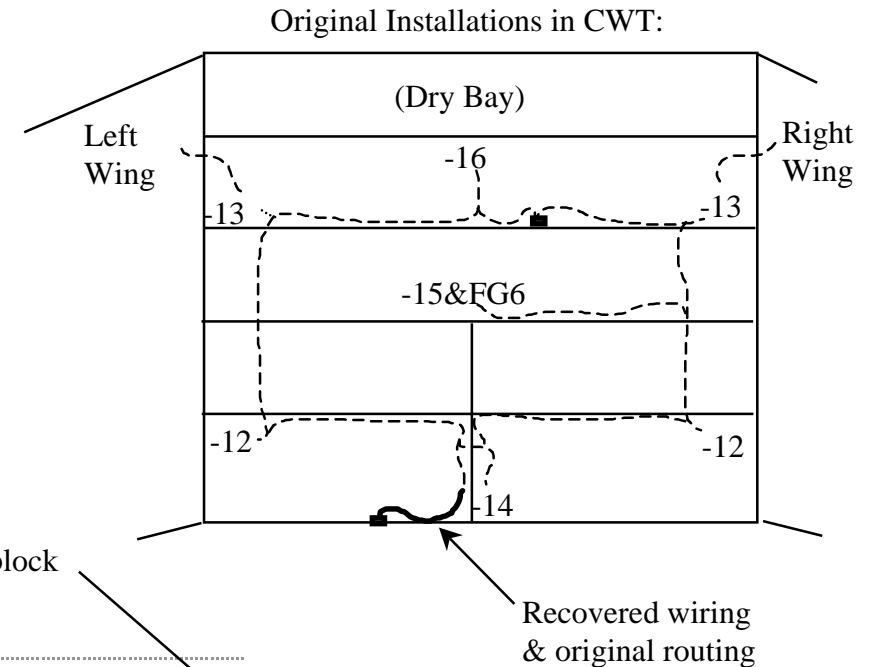


Robert L. Swaim

TWA 800 Systems Group Chairman



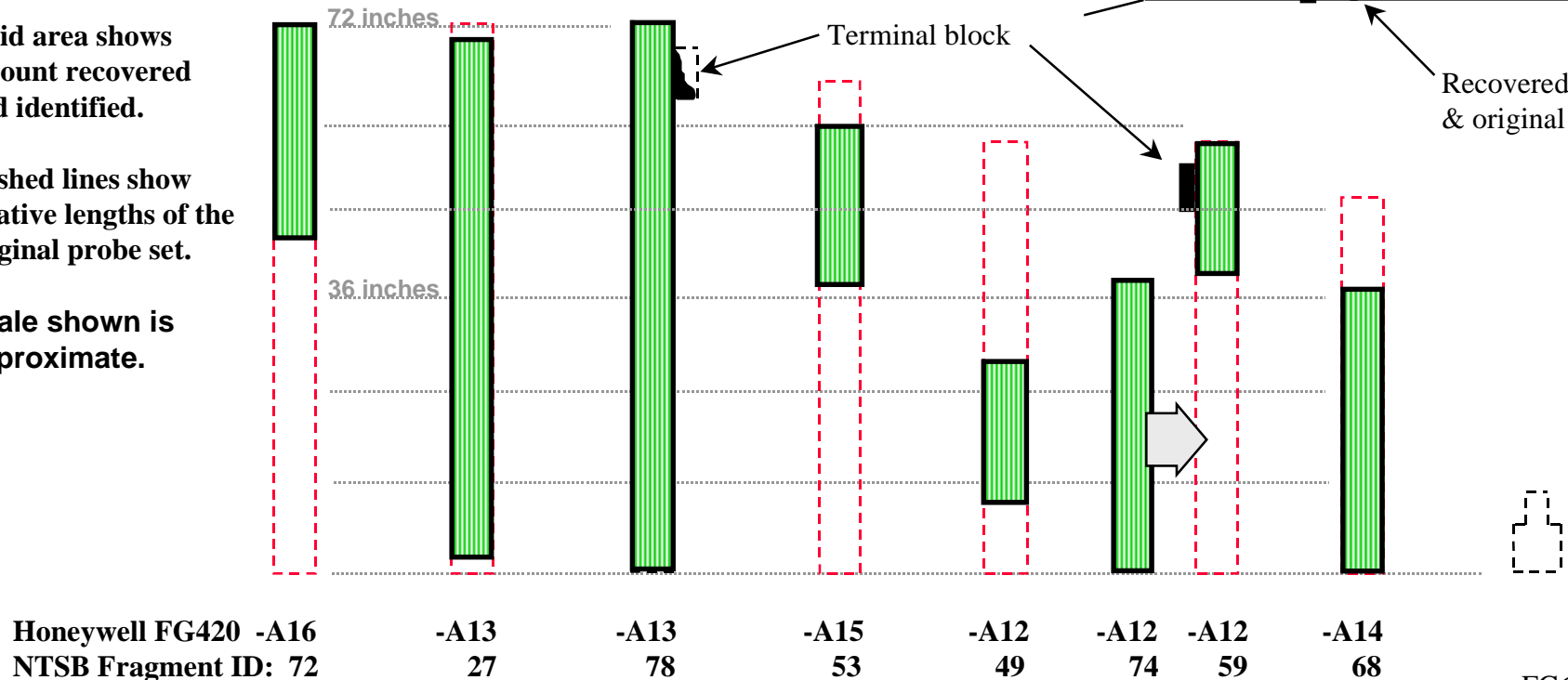
CWT Fuel Probe Fragments Recovered and Identified From TWA 800



**Solid area shows
amount recovered
and identified.**

Dashed lines show relative lengths of the original probe set.

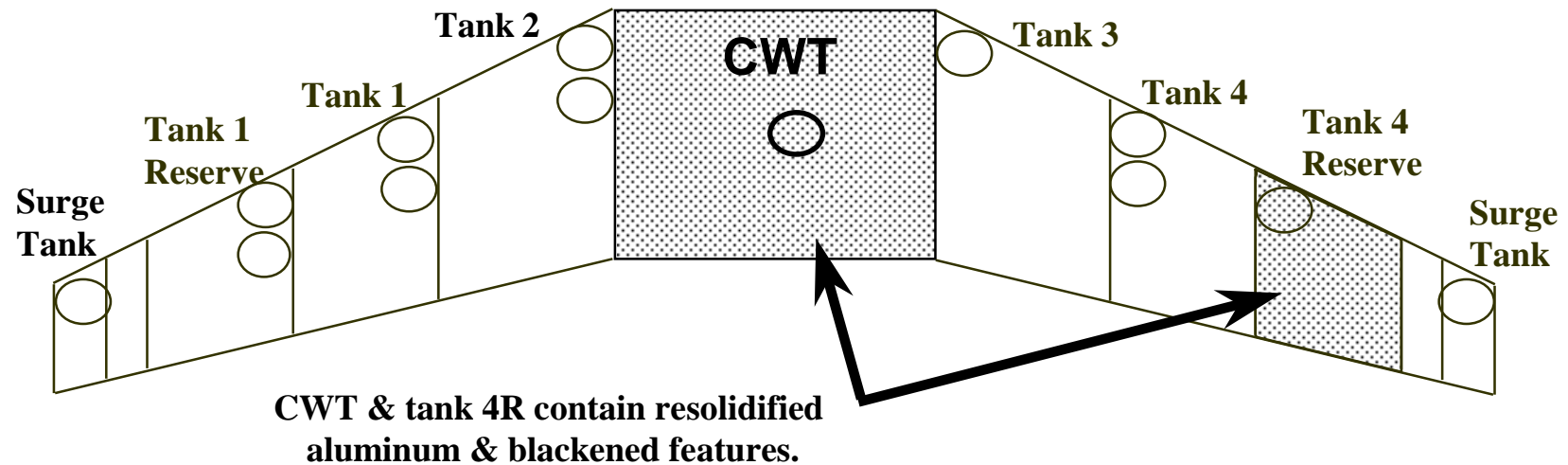
Scale shown is approximate.



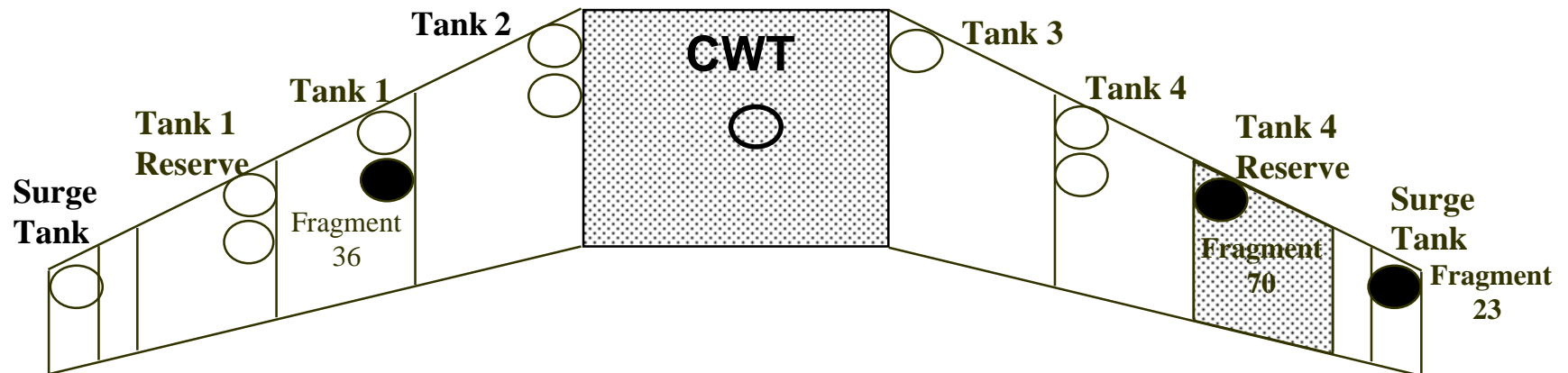
FG6
Compensator
descriptions
are separate.

Note : The FG420-12 and -13 probes are interchangeable and the fragments had no identity as to whether the original locations were on the left or right side of the fuel tank.

THE 13 ORIGINAL LOCATIONS FOR COMPENSATORS ARE SHOWN AS CIRCLES:



OF THE EIGHT COMPENSATORS FOUND, THREE WERE ATTACHED TO IDENTIFIABLE FUEL TANK WIRES OR STRUCTURE FROM THE LOCATIONS SHOWN AS DARKENED CIRCLES:

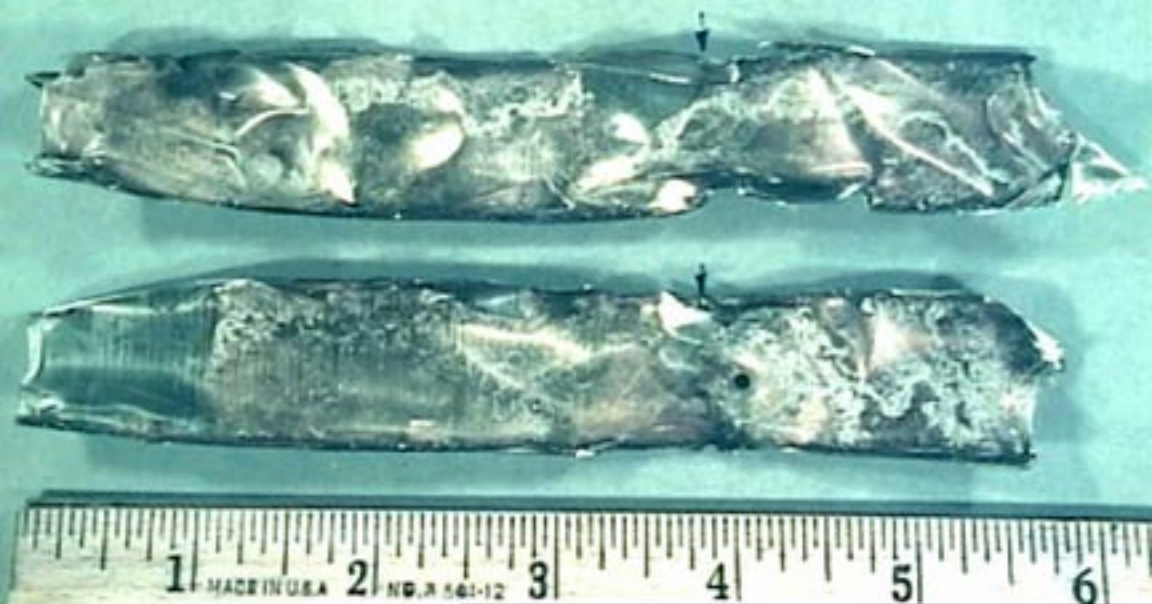


FQIS COMPENSATORS

National Transportation Safety Board - Systems Group

(January 25, 1999)

68



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 1. CWT aft-most fuel probe fragment (lower tip) interior. The arrows mark change in darkening. (No negative)



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 2. CWT fuel probe fragments, as laid out on May 1, 1998. (No negative)



Features of Flattened FQIS Compensator

Systems Group



Flattened FQIS Compensator



Illustration of FQIS Compensator



Localized Blackening and Lip Formed at Bottom of Plastic Sleeve



Localized Blackening on Folded End of Plastic Wire Retainer



The Only Blackened/Sooted Metal was Found at the Bottom

Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 3. Features of Flattened FQIS Compensator (Fragment 80)



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 4. Fragment 80 Compensator after parting flattened upper third.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)
Photo 5. Fragment 80 Compensator on right. Similar part on left.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 6. Fragment 80 Compensator inner features.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 7. Fragment 80 Compensator inner features at bottom. Plastic wire support is folded; bottom is burned end.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 8. Fragment 80 Compensator inner features at bottom. Plastic wire support is folded; bottom is burned end.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 9. Fragment 80 Compensator inner features at bottom. Plastic wire support is folded; bottom is burned end.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 10. Fragment 80 internal HI-Z wire & upper ring connector with splice to shield ground (black wire). Darkened lower features of splice & red insulator are visible.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 11. Fragment 80 internal HI-Z wire & upper ring connector with splice to shield ground (black wire). Darkened lower features of splice & red insulator are visible.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 12. Fragment 80 Compensator internal HI-Z splice with blackened features at the bottom. Localized melting visible at bottom of left photo.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 13. Fragment 80 Compensator interior. Bottom of HI-Z splice showing blackened plastic and deformation.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 14. Fragment 80 Compensator internal upper HI-Z ring connector front and rear. Darkened plastic visible at bottom.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 15. Fragment 80 Compensator internal upper LO-Z ring connector with blackened and deformed lower plastic features. Left photo faces head of screw.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 16. Fragment 80 Compensator upper LO-Z screw end ring with alignment of marks.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 17. Fragment 80 Compensator terminal block teflon insulators, exterior (terminal block) face.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 18. Fragment 80 Compensator terminal block teflon insulator, tube face.



Systems 9 - Exhibit No. 9A - Addendum 1 - (Fuel Probes)

Photo 19. Fragment 80 Compensator parts. Ruler is to right of compensator.

Loose screw at left is misplaced and is upper HI-Z screw.